

The opinion in support of the decision being entered today was *not* written for publication and is *not* binding precedent of the Board.

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE BOARD OF PATENT APPEALS
AND INTERFERENCES

Ex parte BRIAN MICHAEL DAVIS, STEVEN MARK BALLMAN,
EDWARD IVAN STAMM, KURT EDWARD YOUNG,
and JAMES EDWARD GUTKNECHT

Appeal 2006-2987
Application 10/661,651
Technology Center 1700

Decided: March 28, 2007

Before CHARLES F. WARREN, CATHERINE Q. TIMM, and
JEFFREY T. SMITH, *Administrative Patent Judges*.

TIMM, *Administrative Patent Judge*.

DECISION ON APPEAL

Appellants appeal under 35 U.S.C. § 134(a) from the Examiner's decision rejecting claims 1 and 3-20. We have jurisdiction under 35 U.S.C. § 6(b).

We affirm.

I. BACKGROUND

The invention relates to a method of chemical milling at least one blade of a gas turbine engine bladed disk (blisk) to rotationally balance it. These blisks include rotor blades arranged around a disk or hub (Specification Figure 1). According to the Specification, “[a] gas turbine engine blisk is typically manufactured from a one piece solid forging which is conventionally machined using either mechanical machining (mechanical milling) or electrochemical machining (ECM)” (Specification ¶ 0004). But often after machining not all the blades of the blisk have the same dimensions and, therefore, the blades vary in weight (Specification ¶ 0005). The variations cause rotational imbalances during operation in the gas turbine engine (*id.*). Appellants’ method uses a chemical milling method to correct imbalances. Claim 1 is illustrative of the subject matter on appeal:

1. A method for selective chemical milling of a rotationally imbalanced gas turbine engine blisk having a hub and a plurality of blades made of metal spaced circumferentially around the hub and extending radially outwardly therefrom, each of the blades of the blisk having a leading edge, a trailing edge, a chord defined by a line extending from the leading to the trailing edge, a convex curved surface, a concave curved surface and a thickness defined between the convex and the concave surfaces, the method comprising the step of selectively treating at least one blade of the blisk with a chemical etchant of the metal that the at least one blade is made of for a period of time sufficient to change the at least one of the chord and thickness so that the blisk is rotationally balanced.

The Examiner rejects the claims under 35 U.S.C. § 103(a) and relies upon the following prior art references to show unpatentability:

Fishter

US 4,534,823

Aug. 13, 1985

Blake	US 5,126,005	Jun. 30, 1992
Law	US 5,259,920	Nov. 9, 1993
Lowe	US 6,077,002	Jun. 20, 2000

John R. Walker, *Machining Fundamentals* 511-16 (2000)

The Examiner also relies upon the admitted prior art (APA) disclosed in the Specification at paragraphs [0002] through [0008].

The specific rejections under 35 U.S.C. § 103(a) advanced by the Examiner are:

1. Claims 1, 9, and 10 rejected over the combination of either the APA or Lowe with Walker.
2. Claims 2-4 and 11-13 rejected over the combination of either the APA or Lowe with Walker and further with Fishter.
3. Claims 5-7 and 14-17 rejected over the combination of either the APA or Lowe with Walker and Fishter and further combined with Blake.
4. Claims 8 and 18-20 rejected over the combination of the APA or Lowe with Walker and Fishter, and further combined with Law.

II. DISCUSSION

A. The Rejection of Claims 1, 9, and 10

The Examiner rejects claims 1, 9, and 10 over the combination of either the APA or Lowe with Walker. The chemical milling method of claim 1, the broadest of the rejected claims, requires a step of selectively treating at least one blade of a blisk with a chemical etchant.

1. Claim 1

We first consider the contentions as they apply to the broadest claim, i.e., claim 1. The dispositive issue arises out of Appellants' contention that there is no proper motivation for combining the teachings of the APA or

Lowe with the teachings of Walker (Br. 6-7). The Examiner responds that there is a basis in the prior art for the finding of a motivation (Answer 8-9). Therefore, the dispositive issue is: Has the Examiner established, by a preponderance of the evidence, a reason, suggestion, or motivation originating from within the prior art for combining the teachings of the applied references?

The issue before us turns on the facts. The following facts are undisputed.

Lowe describes a process of mechanical milling gas turbine engine blisks. According to Lowe, conventional mechanical milling and electrochemical machining (ECM) processes result in variations from blade-to-blade which must be corrected by balancing (Lowe, col. 1, l. 46 to col. 2, l. 65). This balancing process involves milling selected blades of the blisk in order to remove material to balance the blisk (Lowe, col. 2, ll. 61-64). Furthermore, in the conventional methods, because the blades are freestanding or radially cantilevered, they elastically deflect under the force of the semi-finishing ball mill (Lowe, col. 2, ll. 34-41). The corrections that must be made to accommodate the deflection increase milling time (Lowe, col. 2, ll. 41-44).

The APA includes a disclosure similar to that in Lowe (*Cf.* Specification ¶ 0004-0006). Like Lowe, the APA discloses that “[a] gas turbine blisk is typically manufactured from a one piece solid forging which is conventionally machined using either mechanical machining (mechanical milling) or electrochemical machining (ECM) (Specification ¶ 0004). However, due to manufacturing tolerances and the inherent variation within the manufacturing processes, there are typically differences in the

dimensions of the blades causing differences in the weight of the blades and rotational imbalances during operation (Specification ¶ 0005). The APA discloses that, “[i]n the past, this rotation imbalance problem in gas turbine engine blisks has been addressed by one of two methods.” (Specification ¶ 0006). The APA further discloses one of the methods “is to mechanically polish or machine the blisk to remove metal from the blades, flanges and/or platform region between the blade roots to adjust the rotation balance of the blisk.” (*Id.*). Further according to the APA, “conventional balancing machines have been used to measure the imbalance of the blisk at a suitable speed in terms of an imbalance force vector having a magnitude in mass and radius, and at a measured circumferential angular position around the circumference of the blisk relative to any suitable reference portion.” (Specification ¶ 0007). Further according to the APA, the measured imbalance can then be corrected by removing blisk material (e.g., from the blade) at the angular position of the imbalance vector (*Id.*)

Walker describes chemical milling (chem-milling or contour etching) for removing material from contoured or shaped metal parts (Walker, pp. 511-513). Walker states that “chem-milling may be employed to reduce the weight of sheet metal parts, critical to aerospace vehicle performance.” (Walker, p. 511, § 28.1.1, first paragraph). The caption under Figure 28-1 further states that “[c]hemical milling is employed to remove metal to close tolerances.” Walker further states that “[c]hem-milling and conventional milling are complementary processes” and “refinements in chem-milling make it possible to remove metal to form shapes or microscopic parts that would be difficult or impossible to do by conventional machining techniques.” (Walker, p. 512, first full paragraph). Chemical milling also

has low tooling costs and does not result in burrs (Walker, pp. 512-13, list of advantages).

To support a prima facie case of obviousness, an examiner must show, by a preponderance of the evidence, that a person of ordinary skill in the art, possessed with the understanding and knowledge reflected in the prior art, and motivated by the general problem facing the inventor, would have been led to make the combination recited in the claims. *In re Kahn*, 441 F.3d 977, 988, 78 USPQ2d 1329, 1377 (Fed. Cir. 2006). A suggestion, teaching, or motivation to combine the relevant prior art teachings does not have to be found explicitly in the prior art, as the teaching, motivation, or suggestion may be implicit from the prior art as a whole, rather than expressly stated in the references. *In re Kahn*, 441 F.3d at 987-88, 78 USPQ2d at 1336.

We begin the analysis by considering the prior art from the viewpoint of one of ordinary skill in the art. *See In re Kotzab*, 217 F.3d 1365, 1369, 55 USPQ2d 1313, 1316 (Fed.Cir.2000) (“A critical step in analyzing the patentability of claims pursuant to section 103(a) is casting the mind back to the time of invention, to consider the thinking of one of ordinary skill in the art, guided only by the prior art references and the then-accepted wisdom in the field.”).

A preponderance of the evidence supports the Examiner’s finding of a reason, suggestion, or motivation from within the art for using chemical milling to accomplish rotational balancing of blisks. Lowe recognizes that to balance a blisk, individual airfoil blades may require additional milling (Lowe, col. 2, ll. 61-62). Chemical milling, according to Walker, was a known alternative to the more traditional mechanical milling technique (Walker, p. 511, col. 1). Chemical milling like mechanical milling serves to

remove material from the metal workpiece. When faced with the problem of removing metal to balance blisks, one of ordinary skill in the art would have selected chemical milling because, as discussed by Walker, chemical milling can remove material to exacting tolerances, has low tooling costs, and does not result in burrs. Contrary to the arguments of Appellants (Br. 5), “exacting tolerances” as used in Walker refers the ability to closely control the amount of material removed, it does not refer to making “exact blades” within the blisk. The evidence is sufficient to support the finding of the Examiner.

Because the Examiner established, by a preponderance of the evidence, a reason, suggestion, or motivation originating from within the prior art for combining the teachings of the applied references, we conclude that the Examiner has established a prima facie case of obviousness that has not been sufficiently rebutted by Appellants. Appellants have not convinced us of any reversible error by the Examiner with regard to the rejection of claim 1.

2. Claim 9

The Examiner also rejected claim 9 over the combination of either the APA or Lowe with Walker. Claim 9 is directed to a method for rotationally balancing a blisk. This claim sets forth the specific steps of balancing as follows:

- (a) evaluating the rotationally imbalanced blisk to determine the direction and magnitude of the rotational imbalance;
- (b) identifying at least one blade of the rotationally imbalanced blisk for potential treatment with a chemical etchant to correct the rotational imbalance of the blisk;

- (c) determining which of the at least one blade should be treated with the chemical etchant to correct the rotational imbalance of the blisk; and
- (d) selectively treating the determined at least one blade of the blisk with a chemical etchant of the metal that the at least one blade is made of for a

Appellants contend that “step (b) of Claim 9 (identifying at least one blade of the rotationally imbalanced blisk for potential treatment with a chemical etchant to correct the rotational imbalance of the blisk) is not entirely taught in [the APA].” (Reply Br. 4). Appellants similarly argue that steps (c) and (d), with emphasis on the portions of those steps directed to chemical milling, are not entirely taught by the APA (Reply Br. 4-5).¹ The Examiner responds with citations to specific portions of the APA to support the finding that the APA teaches the claimed steps (b), (c), and (d) albeit in the context of mechanical milling instead of chemical milling (Answer 7). The Examiner relies upon Walker to support the finding of a reason, suggestion, or motivation for using chemical milling in the conventional balancing process. Appellants also again contend that the Examiner’s finding of a reason, suggestion, or motivation to combine the teachings of the APA with those of Walker is erroneous (Reply Br. 5). The dispositive issue, therefore, is the same as that addressed above in reference to claim 1: Has the Examiner established, by a preponderance of the evidence, a reason, suggestion, or motivation originating from within the prior art for combining the teachings of the applied references?

For reasons similar to those provided above in reference to claim 1, a preponderance of the evidence supports the Examiner’s finding of a reason,

¹ Appellants concede in the Reply Brief that the Examiner has properly identified step (a) of claim 9 (Reply Br. 4).

suggestion, or motivation from within the art for using chemical milling to accomplish rotational balancing of blisks. The APA recognizes that dealing with the balancing problem requires appropriate assessment of where and to what degree the imbalance exists and that this is done using conventional machines to measure the imbalance and then correcting the imbalance by removing blisk material (Specification ¶ 0007), the traditional removal method being one of mechanical machining or milling (Specification ¶ 0006). Chemical milling, according to Walker, was a known alternative to the more traditional mechanical milling technique (Walker, p. 511, col. 1). Chemical milling like mechanical milling serves to remove material from the metal workpiece. When faced with the problem of removing metal to balance blisks, one of ordinary skill in the art would have selected chemical milling because, as discussed by Walker, chemical milling removes material to exacting tolerances, has low tooling costs, and does not result in burrs.

We find that the Examiner has provided the necessary evidence to support the Examiner's finding.

We conclude that the Examiner has established a prima facie case of obviousness with respect to the subject matter of claim 9 that has not been sufficiently rebutted by Appellants.

3. Claim 10

Claim 10 was also rejected by the Examiner over either the APA or Lowe in view of Walker. Claim 10 is dependent on claim 9 and further requires a step of determining if the blisk is balanced and, if not balanced, repeating one or more of the steps of balancing until the blisk is balanced.

Appellants contend that in rejecting claim 10 the Examiner has made an unsupported conclusory statement that it would have been obvious "to

repeat the process in order to determine that the blisk is balanced” and that such a conclusory statement is an improper reason for rejecting the claim. The issue, therefore, is whether the Examiner properly supported the conclusion of obviousness.

We are not persuaded that the reason advanced by the Examiner was improper. Implicit in the disclosure of using conventional balancing, is what is well known in the art with regard to conducting such balancing. Balancing on a conventional machine is a reiterative process, it must be repeated until balance is achieved. The test for obviousness is what the combined teachings of the references would have suggested to one of ordinary skill in the art. *In re Young*, 927 F.2d 588, 591, 18 USPQ2d 1089, 1091 (Fed. Cir. 1991); *In re Keller*, 642 F.2d 413, 425, 208 USPQ 871, 881 (CCPA 1981). The suggestion test “not only permits, but *requires*, consideration of common knowledge and common sense.” *DyStar Textilfarben GmbH & Co. Deutschland KG v. C.H. Patrick Co.*, 464 F.3d 1356, 1367-68, 80 USPQ2d 1641, 1650 (Fed. Cir. 2006). “[A] prior art reference must be ‘considered together with the knowledge of one of ordinary skill in the pertinent art.’” *In re Paulsen*, 30 F.3d 1475, 1480, 31 USPQ2d 1671, 1675 (Fed. Cir. 1994).

A preponderance of the evidence supports the finding of the Examiner, therefore, we conclude that the Examiner has established a prima facie case of obviousness that has not been sufficiently rebutted by Appellants. Appellants have not convinced us of any reversible error by the Examiner with regard to the rejection of claim 10.

B. The rejection of Claims 2-4 and 11-13

The Examiner rejects claims 2-4 and 11-13 over APA or Lowe in view of Walker and Fishter. We focus on claim 2 as the claims have not been separately argued. Claim 2 requires that the chemical etchant be an aqueous etchant solution comprising at least one strong acid. The Examiner relied upon Fishter as evidence that such etchant solutions were known in the art for chemical milling nickel superalloys, a type of metal used in blisks (4-5).

Appellants contend that the Examiner has failed to provide a proper motivation for combining the teachings of Fishter with the other references (Br. 7-8). Therefore, the dispositive issue, again, is whether the Examiner established, by a preponderance of the evidence, a reason, suggestion, or motivation originating from within the prior art for combining the teachings of the applied references.

A preponderance of the evidence supports the finding of the Examiner. Fishter describes chemical milling nickel superalloy metal of the type used to produce blisks (Fishter, col. 1, ll. 7-17) using an aqueous solution containing at least one strong acid, i.e. hydrochloric and nitric acids (Fishter, col. 2, ll. 5-22). These facts are not disputed by Appellants. The suggestion flows from the express teaching of Fishter that such strong acids will chemically mill blisks. We do not agree with Appellants that the teaching in Fishter is inadequate to suggest adjusting dimensions of the blisk blades (Br. 8). Appellants acknowledge that Fishter uses chemical milling to remove a surface layer from a machined article (Br. 8). That Fishter discloses that removal as part of an inspection process for surface defects does not negate the teaching that the process is one of chemical milling involving removal of metal. That the milling of Fishter is said not to have

any “adverse metallurgical affect on the structure being inspected” further does not negate the teaching of using strong acid to remove metal by chemical milling. That there is no “adverse metallurgical affect” simply means there are no adverse changes in the metallurgy, i.e., the properties and morphology, of the metal alloy.

Because the Examiner established, by a preponderance of the evidence, a reason, suggestion, or motivation originating from within the prior art for combining the teachings of the applied references, we conclude that the Examiner has established a prima facie case of obviousness that has not been sufficiently rebutted by Appellants. Appellants have not convinced us of any reversible error by the Examiner with regard to the rejection of claim 2 and claims 3, 4, and 11-13 falling therewith.

C. The Rejection of Claims 5-7 and 14-17

The Examiner rejected claims 5-7 and 14-17 over APA or Lowe in view of Walker, Fishter, and Blake.

1. Claim 5

Claim 5 is the broadest of the rejected claims and involves applying a maskant to a blade prior to immersion in the treating solution so that the blade is not treated. The Examiner relies on Blake to show that it was known in the chemical etching art to use masks to protect regions of a metal part from etching solutions.

Appellants contend that the Examiner has failed to allege a proper motivation for combining the teachings of Blake with the teachings of the other references (Br. 9-10). The issue, again, is: Has the Examiner established, by a preponderance of the evidence, a reason, suggestion, or

motivation originating from within the prior art for combining the teachings of the applied references?

The Examiner has supported the finding of a suggestion by a preponderance of the evidence. Appellants do not dispute the Examiner's findings with regard to what Blake teaches. Appellants merely assert that Blake does not teach applying the maskant to blisk blades, but instead applies the maskant to airplane skin (Br. 10). There is no dispute in that regard. The suggestion to apply a maskant to a blisk blade comes from the problem to be solved, i.e., the problem of treating only those portions of the blisk blades where material is to be removed. Blake provides evidence that it was known to solve that problem by applying a maskant before immersion in the chemical milling bath to protect the areas where material is not to be removed. Walker also teaches applying a mask before immersion (Walker, p. 512, "Steps in chemical milling").

Because the Examiner established, by a preponderance of the evidence, a reason, suggestion, or motivation originating from within the prior art for combining the teachings of the applied references, we conclude that the Examiner has established a prima facie case of obviousness that has not been sufficiently rebutted by Appellants. Appellants have not convinced us of any reversible error by the Examiner with regard to the rejection of claim 5.

2. Claims 7 and 16

With respect to claims 7 and 16, Appellants contend that Blake does not teach or suggest that reimmersion after removal of the maskant is desirable, such removal and reimmersion being required by claims 7 and 16 (Br. 11). However, as found by the Examiner, Blake indicates that a

chemical milling method consisting of a plurality of masking, removal, and etching steps was known in the art (Blake, col. 1, ll. 31-35). While that process is not the focus of the invention of Blake and, therefore, is not discussed as a preferred process, use of a patent as a reference is not limited to what the patentee describes as their own invention. *In re Heck*, 699 F.2d 1331, 1333, 216 USPQ 1038, 1039 (Fed. Cir. 1983) (*quoting In re Lemelson*, 397 F.2d 1006, 1009, 158 USPQ 275, 277 (CCPA 1968)). The fact remains that Blake describes selective chemical milling can be accomplished by repeatedly masking, removing, and etching. Balancing, as required by the APA and Lowe, requires selective removal of metal from the Blisk, and Blake describes a process of accomplishing selective removal. Therefore, the evidence is sufficient to support the Examiner's finding of a reason or suggestion within the prior art for removing the maskant and reimmersing the Blisk of the prior art to balance it. Appellants have not convinced us of any reversible error by the Examiner with regard to the rejection of claims 7 and 16.

3. Claim 17

With respect to claim 17, Appellants contend that nowhere does the Examiner allege where the combination of prior art teaches or suggests immersing solely the treated blade(s) in the etchant solution to achieve rotational balance of the blisk according to claim 17 (Br. 11-12).

The Examiner contends that claim 17 reads broadly on the immersion of any number of blades because any blades that are immersed are effectively treated (Answer 10).

The issue is: Does the prior art suggest immersing in accordance with claim 17?

Claim 17 requires selectively immersing solely the blade or blades to be treated until the blisk is balanced. There is no limit on the number of blades that can be immersed, however, blades that are not treated are not immersed. That is not to say that the claim excludes masking portions of blades to be treated.

The prior art provides a suggestion of immersing just those portions of the workpiece to be treated and, therefore, we find a reason or suggestion to immerse only those blades to be treated in conformance with claim 17. This is because, as described by Walker, chemical milling is a process in which the part is immersed in an etchant and the resulting chemical action removes the metal (Walker, p. 511, col. 2). Walker describes applying maskants to the areas to be immersed but not etched (Walker, pp. 511-12), but also describes producing tapers by immersing the portion to be tapered and withdrawing the workpiece from the etchant at a predetermined rate (Walker, caption to Fig. 28-3). Those portions out of contact are not further etched. One of ordinary skill in the art would understand that only those portions of metal contacting the etching solution within the bath will be treated. It follows that it would have been obvious to place only those portions to be treated in the etchant bath when that was possible.

The prior art suggests immersing as claimed. Appellants have not convinced us of a reversible error on the part of the Examiner with regard to the rejection of claims 17.

D. The Rejection of Claims 8 and 18-20

Claims 8 and 18-20 are rejected over APA or Lowe in view of Walker, Fishter, and Law.

1. Claim 8

Claim 8 is the broadest of the argued claims and, therefore, in considering the general issues for this group of claims, we select claim 8 to represent the issues on appeal. Claim 8 requires immersing a reference panel of the same metal as the blade being treated in the etchant solution to monitor particular dimensional changes and/or hydrogen absorption.

Appellants contend that there is no proper motivation taught in Law for combining the teachings of this reference with those of the other references (Br. 13-14). Appellants point out that Law monitors the etching of a pattern rather than the change in dimension of a part and the two are not equivalent (*Id.*).

The issue is: Has the Examiner provided support by a preponderance of the evidence for the finding of a reason, suggestion, or motivation arising from within the prior art?

The evidence sufficiently supports the finding of the Examiner. As found by the Examiner, Law describes a process of monitoring the removal rate during etching (Answer 6; Law, col. 1, ll. 6-10). The reference panel is merely a layer of metal on a substrate that is immersed in the same bath as the workpiece (Law, col. 1, ll. 41-63). The cumulative amount of metal removed at any given time from the workpieces and the reference panel is directly indicated by the location of the edge of the indicator layer (Law, col. 1, ll. 63-68). The function of the reference panel is the same whether the workpiece is etched in a pattern, i.e., masked so that only a pattern is etched, or completely etched, i.e., immersed without masking. Therefore, its use in monitoring of etching processes such as chemical milling is evident from the nature and function of the process.

Because the Examiner established, by a preponderance of the evidence, a reason, suggestion, or motivation originating from within the prior art for combining the teachings of the applied references, we conclude that the Examiner has established a prima facie case of obviousness that has not been sufficiently rebutted by Appellants. Appellants have not convinced us of any reversible error by the Examiner with regard to the rejection of claim 8.

2. Claim 19

With regard to claim 19, Appellants contend that the Examiner has failed to address where Law, or the other prior art relied upon by the Examiner, teaches the use of the metals recited in claim 19 in a reference panel.

The Examiner responds that the metals are well known for the construction of turbine blades, as shown by Fishter for example, and, therefore, these metals would have been obvious for use as reference panel metals (Answer 6).

The issue is whether the prior art supports the determination of the Examiner that it would have been obvious to use the metals of claim 19 in a reference panel.

Appellants have not convinced us of a reversible error on the part of the Examiner. Law teaches using the metal that is to be etched as the “indicator layer” (Law, col. 1, ll. 53-56). For a turbine blade etching process, the reference panel metal will be the same as the turbine blade metal. The Examiner finds that the metals of claim 19 were well known for the construction of turbine blades and offers Fishter as evidence (Answer 6). Appellants do not dispute that the claimed metals were well known for use

in turbine blades. Moreover, Fishter describes a IN-100 nickel superalloy, a metal within the scope of claim 19, for such a use. The evidence is sufficient to support the determination of the Examiner.

III. DECISION

We affirm the decision of the Examiner to reject the claims as obvious under 35 U.S.C. § 103(a).

Specifically, we sustain the rejection of (1) claims 1, 9, and 10 over the APA or Lowe with Walker, (2) the rejection of claims 2-4 and 11-13 over those references in combination with Fishter, (3) the rejection of 5-7 and 14-17 over the APA or Lowe with Walker, Fishter and Blake, and (4) the rejection of claims 8 and 18-20 over the APA or Lowe, with Walker, Fishter, and Law.

IV. TIME PERIOD FOR RESPONSE

No time period for taking any subsequent action in connection with this appeal maybe extended under 37 C.F.R. § 1.136(a)(1)(iv).

AFFIRMED

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